

FOOD AND PREDATION RISK AS FACTORS RELATED TO FORAGING LOCATIONS OF NORTHERN FLICKERS

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ABSTRACT.—Foraging site selection by birds may be related to foraging efficiency, food availability and abundance, and predation risk. We identified selectively used foraging habitat within home ranges of 29 adult radio-tagged Northern Flickers (*Colaptes auratus*) in British Columbia during the nestling period. We compared habitat characteristics of flicker foraging locations to randomly selected locations in their home range using discriminant function analysis. Foraging plots were located in grassland and were characterized by a lack of tall vegetation, a large percentage of bare ground, and a high density of small anthills. Foraging plots had five times more anthills than random plots. Foraging plots also were closer to trees and forest edges than random plots. The random plots had significantly more medium and tall vegetation than foraging plots, and litter (dead grass) was the most abundant type of cover. Mortality of adult flickers attributed to avian predation while foraging was 14% during 1999 and 3% during 2000. The sparse ground cover of foraging plots likely increased access to food, whereas foraging near trees likely decreased avian predation. The marked selectivity of foraging areas by flickers suggests that foraging ability could be negatively affected by land use practices that alter the structure of ground cover. Received 3 October 2001, accepted 6 June 2002.

Foraging behavior of birds is influenced by time and energy spent searching for and handling prey, as well as the energetic content of food (MacArthur and Pianka 1966, Schoener 1971, Stephens and Krebs 1986). For central place foraging birds, which initiate and end foraging trips from and to the same location (e.g., a nest), the cost of foraging also may include increased predation risk and increased time and energy expenditure the farther the distance traveled from the nest to the foraging site (Johnson and Swihart 1989). Foraging animals generally should try to maximize rate of energy gain and minimize costs of foraging and predation risk (Krebs 1980). The selection of a foraging location, therefore, should be based on perceived predation risk, food abundance and availability, foraging efficiency, and intraspecific or interspecific competition (Gamboa and Brown 1976, Eiserer 1980, Lima and Dill 1990, Giesbrecht and Ankney 1998, Rolstad et al. 2000).

Several studies of ground-foraging birds have implicated predation risk, food abundance, or food availability as important determinants of foraging location; however, these relationships are complex. For example, Dark-eyed Juncos (*Junco hyemalis*), House Sparrows (*Passer domesticus*), and White-crowned

Sparrows (*Zonotrichia leucophrys*) foraged at feeders closer to tree cover when given a choice, and shifted to farther feeders as food became depleted near tree cover (Schneider 1984, Giesbrecht and Ankney 1998). In another study, however, three species of ground-feeding sparrows experienced a trade off between foraging too close to protective cover, which may harbor predators, and foraging too far away from cover to escape from an attacker (Lima et al. 1987). Foraging in tall vegetation can provide better cover from avian predators but also may impede movement and impair foraging efficiency as well as decreasing detection distance of predators. Shorter vegetation may result in greater exposure to predators but allow a quicker detection rate and greater foraging efficiency (Roth 1979, Eiserer 1980, Ostrand et al. 1996). For example, Brown-headed Cowbirds (*Molothrus ater*) foraged in short grazed grasslands where invertebrate density was greater than in tall vegetation, although their vigilance in the former type of habitat also was highest (Morris and Thompson 1998). Presumably, combinations or trade offs among multiple factors such as food abundance, distance traveled, and predation risk yields the optimal solution for a choice of foraging patch (Covich 1976).

Woodpecker species often have specialized diets and foraging habitat requirements (Williams 1975). During summer, most woodpeckers forage on ants and insect larvae that they

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obtain from crevices in trees or by removing bark and excavating holes in infected dead wood (Short 1982). Varying sizes, ages, or areas of the tree often are used by different woodpecker species or sexes within species (Kilham 1965, Jackson 1970, Williams 1975, Gamboa and Brown 1976, Conner 1980, Torgersen and Bull 1995, Fayt 1999). The Northern Flicker (*Colaptes auratus*) is a unique North American woodpecker because it forages almost exclusively on the ground during summer, specializing on ants and beetle larvae (Beal 1911, Cruz and Johnston 1979). The brownish barred plumage of the Northern Flicker also differs from the conspicuous black, white, and red coloration of most other woodpecker species, which suggests that predation risk during foraging may have favored cryptic plumage. However, there are no data on mortality rates of adults during breeding to assess levels of predation.

Flickers play a keystone role in many northern forest communities as the most active cavity nest excavators (Martin and Eadie 1999, Aitken et al. 2002), yet little is known about their habitat use while foraging. Habitat selection can occur on a hierarchal scale, from the choice of a home range on the landscape to the choice of a food item on a feeding site (Johnson 1980). Our goal in this study was to focus on selection of foraging habitat at the scales of feeding sites within home ranges, and food items within feeding sites. This was accomplished by comparing characteristics of foraging plots to random plots in the home range. We predicted that foraging sites would have a greater density of ants, the main prey of flickers, and that flickers would forage close to protective cover to minimize predation risk. Because no data exist on mortality rates of flickers associated with predation, we also analyzed the fate of the radio-tagged individuals.

METHODS

Study area and radio telemetry.—We conducted the research from May to July 2000 in central interior British Columbia near Riske Creek (51° 52' N, 122° 21' W). The study area encompassed about 200 km² of grassland with aspen (*Populus tremuloides*) groves, mixed forest (Douglas fir, *Pseudotsuga menziesii*; lodgepole pine, *Pinus contorta*; and aspen) and scattered lakes and ponds. Cattle grazed on the entire study area for a few weeks during May and September.

During mid-May, we trapped adult flickers at the nest during incubation and banded them with a unique combination of colored leg bands (see Wiebe 2001, Wiebe and Swift 2001). We aged birds as yearlings or adults (≥ 2 years) using molt criteria Pyle et al. (1997) and recorded sex. We attached radio transmitters (Hohloh Systems Ltd., Ontario, BD-2G) weighing 1.8 g to the central rectrices of flickers using cyanoacrylate glue (Kenward 1987) and microfilament line. The radios represented approximately 1% of the body mass and therefore were unlikely to affect behavior (Cochran 1980, Wanless 1992, Wiklander et al. 2001). From a sample of about 80 breeding pairs that we banded, we arbitrarily selected 29 flickers (14 males, 15 females) for radio tracking, using only one individual per pair.

We radio tracked each flicker during 2.5-h sessions, which were rotated among three observers and three time periods: morning (07:00–11:00 PST), midday (11:00–14:00), and afternoon (14:00–18:00). Tracking sessions occurred 6–8 times for each bird, beginning when nestlings were about five days old, when they no longer required constant brooding, and continued until the chicks fledged about 20 days later. During tracking sessions, we marked the target bird's location every 30 min, which allowed us to delineate home range boundaries and identify locations where the bird was foraging. We obtained the locations by a visual sighting of the birds with binoculars from a distance in an attempt not to flush them. We marked the locations with flagging tape after the bird had left the area and recorded the UTM coordinates using a global positioning system. Due to difficulties in observing good foraging points during all 6–8 tracking sessions, we measured only 3–4 randomly selected foraging points per bird to weight the data from all individuals and all home ranges equally. To avoid sampling the same area of the home range repeatedly, we used only one foraging point per tracking session.

Characteristics of foraging and random plots.—We evaluated characteristics of foraging locations either immediately following the tracking session or within one week, in which case the areas were described in the field notes on the day of observation. At each foraging location, we assessed habitat characteristics in a 1-m² quadrat. We visually assessed the ground coverage (in %) of the following: bare ground, lichen, rock, cow dung, dead standing vegetation (litter), short (<10 cm tall) vegetation, medium (10–20 cm) vegetation, and tall (>20 cm) vegetation. Vegetation height categories were based on a flicker's height. We reasoned that flickers probably would be able to see over short grass while foraging but would have to stand in an upright position to see over medium vegetation, and may have a totally obstructed view in tall vegetation. We measured the proportions of rock and lichen since some ant species construct nests under rocks and lichen (Smallwood and Culver 1979) and we observed flickers probing in the soil around edges of rocks and flipping over pieces of lichen. We counted the number of small (<5 cm diameter) anthills in the quadrat to

TABLE 1. Habitat variables measured for foraging ($n = 29$) and random ($n = 29$) plots in home ranges of Northern Flickers, British Columbia, Canada, 2000. Normally distributed or transformed variables are reported as means or back-transformed means (95% lower confidence limit, 95% upper confidence limit), respectively. When variables could not be normalized, medians (lower (25%) quartiles, upper (75%) quartile) are reported.

Variable	Transformation ^a	Foraging plots	Random plots
Bare ground (%)	ND	22.8 (17.9, 27.8)	5.4 (3.7, 7.2)
Litter (%)	ND	14.6 (11.2, 17.9)	32.3 (27.3, 37.3)
Short vegetation (%)	ND	34.1 (30.0, 38.1)	23.0 (19.0, 27.0)
Medium vegetation (%)	ND	9.8 (8.1, 11.4)	17.0 (14.9, 19.1)
Distance to forest (m)	ND	54.8 (40.1, 69.5)	97.4 (86.2, 108.6)
Nearest tree (m)	ND	11.2 (9.0, 13.4)	17.2 (15.8, 18.6)
Distance to cow dung (m)	ND	4.5 (3.9, 5.0)	6.5 (5.6, 7.4)
Lichen (%)	A	9.7 (6.2, 14.0)	3.5 (1.8, 5.8)
Rock (%)	A	2.9 (1.8, 4.1)	0.9 (0.4, 1.4)
Tall vegetation (%)	A	1.4 (1.0, 2.1)	14.1 (10.9, 17.7)
Cow dung (%)	—	1.0 (0, 1.5)	1.0 (0, 1)
Number small anthills/m ²	—	5.0 (3.5, 6)	1.0 (0, 1.5)
Number of large anthills	—	0.0 (0, 1)	0.0 (0, 0.5)

^a Transformations applied to data to achieve normality: A, arcsine square root; —, transformation unsuccessful; ND, normal distribution without transformation.

obtain small anthill density. Small anthills were easily visible on bare ground and in short vegetation, but we also looked for them on the ground under taller vegetation and litter, which can accumulate to a depth of about 15 cm.

We measured the distance from the center of the quadrat to the nearest tree within 20 m. We chose 20 m as the limit for tree cover because trees farther than 20 m from a foraging location probably would not provide protection in the event of a surprise attack from an avian or mammalian predator. We measured the distances to the nearest five productive cow dung pats within 20 m and we calculated the mean value for each quadrat. We considered cow dung productive if it contained items such as eggs, pupae, larvae, or adult ants or beetles, therefore providing an available food source for flickers. Also, we counted the number of large (15–30 cm diameter) anthills within 20 m of the foraging plot and estimated the distance to the nearest forest edge.

We compared foraging plots to random plots, selected to represent available grassland habitat within each home range. For each foraging plot, we used a random numbers generator to establish two plots at random distances from the nest but within the home range boundaries. One plot was established at a random direction determined by a blind twist of the compass dial while the other was placed in the same direction as the foraging plot being measured. We did not establish any random plots in the forest because we rarely observed flickers foraging there, and all foraging plots were located in grassland or edge (≤ 20 m from forest) habitats. We used identical methodology to assess characteristics of random and foraging plots, and we measured random plots at the same time as the corresponding foraging plot.

Data analysis.—For analysis, we used the mean val-

ues of each variable for the 3–4 foraging plots and 6–8 random plots in each home range of each individual for a total of 29 foraging plots and 29 random plots. We tested habitat variables for normality using a one-sample Kolmogorov-Smirnov test at the 95% confidence level (Zar 1999), and transformed variables when necessary (Table 1). We used two-sample *t*-tests to compare variables that the multivariate analysis suggested were important.

Because the ground cover variables sum to 100%, we excluded lichen from the multivariate analyses to avoid statistical redundancy. Therefore, we entered 12 habitat variables into two multivariate ordination techniques. We performed principal component analysis (PCA) to explain the greatest percent of total variance in the variables (Tabachnick and Fidell 1983). A scree test, a plot of the variance associated with each component, was generated in PCA to determine the number of components to consider in the analysis. Subsequently, we used stepwise discriminant function analysis (DFA) to identify the subset of variables most effective at discriminating between random and foraging plots and to determine their success at predicting correct plot classification (Tabachnick and Fidell 1983). We also compared foraging plot characteristics between sexes using DFA. A correlation matrix was used in the DFA and PCA to standardize the variables measured in different scales. A variable was entered into the DFA model if the probability level of its *F* value was < 0.05 and was removed if it was > 0.10 .

Fate of radio-tagged flickers.—During tracking sessions, we visually located the birds so we were able to confirm whether the bird was alive, dead, or lost. If the bird was found dead, we assessed whether it was eaten by a mammal or avian predator by the condition of the carcass and the way the feathers had been plucked or chewed. Although we relocated birds every

2–3 days during the brood-rearing period, we could not eliminate the possibility that the bird had initially died of natural causes or disease, and was scavenged later. Since we placed radio transmitters on birds during early incubation and began radio tracking when chicks were about 5 days old, there was a ≥ 10 -day adjustment period for the birds with the radio transmitters. Since no birds died during this period, we assumed that mortality was not a direct result of radio tagging.

We considered a bird lost if the signal was not detected within the study area or if the radio came off the bird. Lost birds ($n = 17$) were never detected again, so they were not included in the mortality estimate because we had no knowledge of their fate. Also, since there were no cases where a radio-tagged bird was not detected and then later found (i.e., no detection failures), we defined mortality rate as the number of radio-tagged birds found dead divided by the total number of birds radio tagged (excluding lost birds) $\times 100$ during the brood-rearing period, approximately 24 to 27 days. This estimate is therefore not representative of mortality rate during the summer, but during the time adults have chicks in the nest.

RESULTS

Characteristics of foraging and random plots.—Short vegetation and bare ground were the most abundant types of ground cover in foraging plots whereas tall vegetation was the least common (Table 1). In the random plots, litter was most abundant whereas rock, lichen, and bare ground made up only a small percentage of cover (Table 1).

There were five times more small anthills in foraging plots than in random plots (Mann-Whitney $U = 32.0$, $n = 58$, $P < 0.001$; Table 1). All foraging plots contained at least one small anthill (range = 1–21, median = 5). Random plots had a median of one anthill and often contained none. We found no evidence of probe marks indicating flicker foraging in any of the random plots. In contrast, the ground in the foraging plots usually had multiple probe marks and soil or lichen turned over with ants scattered over the surface, sometimes carrying larvae, pupae, or eggs. Foraging plots also often had numerous probe marks around the edges of rocks, under which were ant colonies.

Random plots were twice the distance to forest edge as were foraging plots (two-sample $t = -4.723$, $df = 56$, $P < 0.001$; Table 1). Foraging plots were a mean distance of 11 m from the nearest tree compared to 17 m for

random plots (two-sample $t = -4.735$, $df = 56$, $P < 0.001$; Table 1).

Two components were considered in the PCA based on a break in the slope of a scree test. Together, PCA axes 1 and 2 explained 49.4% of the variance with axis 1 alone explaining 34.1% (Fig. 1). Greater numbers on PCA 1 represented increases in the density of ground cover. Bare ground and number of ant-hills were highly negatively correlated with axis 1 and associated with foraging plots, whereas litter and tall vegetation were highly positively correlated with axis 1 and associated with random plots (Fig. 2). PCA 2 appeared to measure distance to cover; positive values indicated a long distance to a tree or forest edge (Fig. 2). Overall, foraging and random plots were distinct as shown by the small overlap between the groups on the scatterplot (Fig. 1).

Using DFA to distinguish plots.—The DFA retained five variables as potential discriminators of foraging and random plots ($P < 0.001$; Table 2), while the other nine were statistically redundant and discarded. Density of small anthills was the strongest discriminating variable between foraging and random plots (Table 2). Tall grass also was important, with random plots having taller vegetation than foraging plots. Foraging plots also could be distinguished by having more bare ground, being closer to forest edges, and closer to a tree (Tables 1 and 2). The discriminant function of the entire data set had an overall classification success of 98.3%. No variables were kept in a DFA model testing for differences in foraging plots between males and females, indicating that characteristics of foraging areas did not differ significantly between the sexes.

Predation on radio-tagged flickers.—Although we did not observe any radio-tagged flickers being killed by predators during tracking sessions, we found the remains of radio-tagged birds both in and away from the nest. We saw flickers being chased by Cooper's (*Accipiter cooperii*) and Sharp-shinned (*A. striatus*) hawks. We observed coyotes (*Canis latrans*), red foxes (*Vulpes fulva*), martens (*Martes americana*), fishers (*Martes pennanti*), longtail weasels (*Mustela frenata*), and minks (*Mustela vison*) during the study, but they were not stalking birds.

During 1999, one male and three females

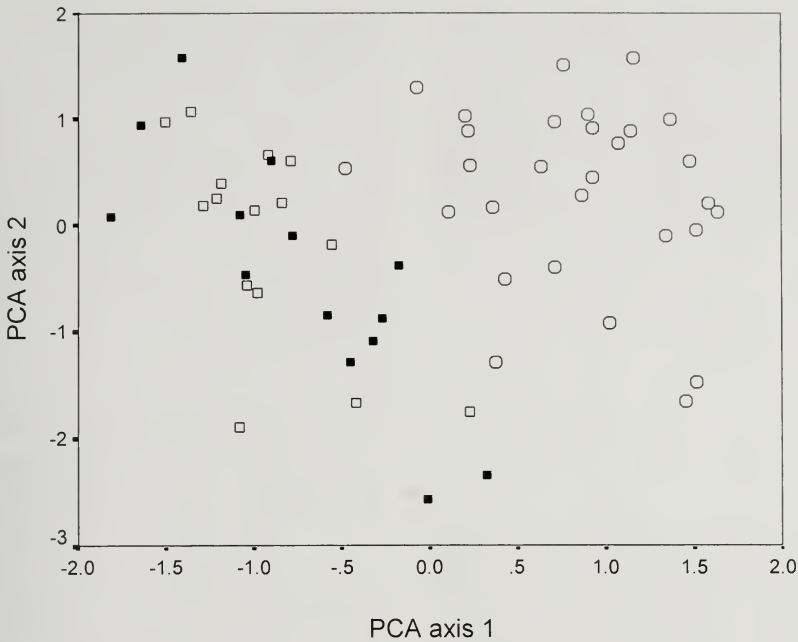


FIG. 1. Scatterplot of PCA scores for random (circles) and foraging (squares) plots within home ranges of 29 Northern Flickers, British Columbia, Canada, 2000. Foraging and random plots show little overlap whereas foraging sites used by males and females (open and filled symbols, respectively) overlap extensively. The structure of each PCA axis is illustrated in Fig. 2.

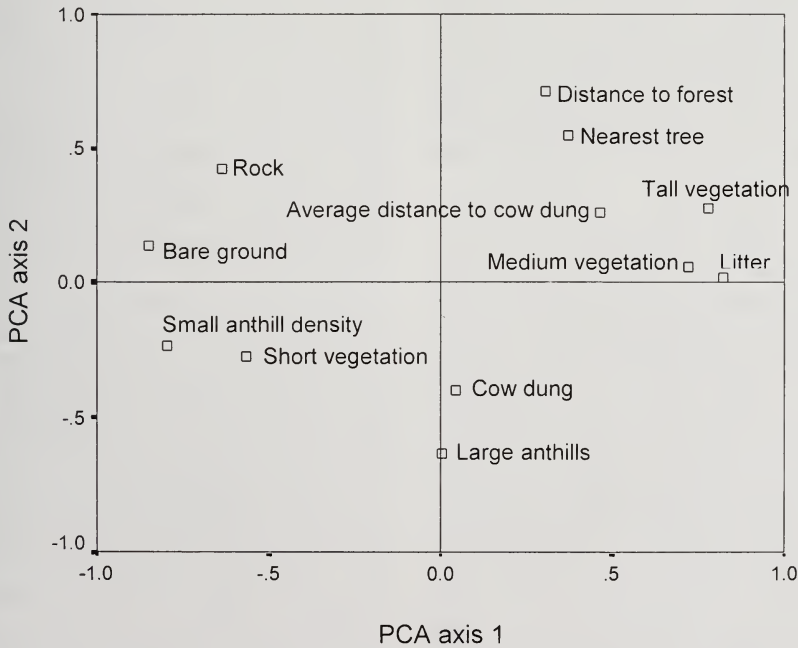


FIG. 2. Plot of component loadings of the habitat variables on the first two axes in principal component analysis after varimax rotation. Habitat variables were measured in foraging and random plots of home ranges of Northern Flickers in British Columbia during the breeding season of 2000. Axis 1 represents mainly ground cover whereas axis 2 is influenced strongly by distance to protective cover such as trees or forest.

TABLE 2. The subset of variables from Table 1 retained by a discriminant function analysis as the most important to distinguish between foraging and random plots. Foraging and random plots were located in 29 home ranges of Northern Flickers in British Columbia in 2000. Positive signs for the pooled within group correlations show that the variable was positively correlated with random plots and negative signs indicate negative correlations with foraging plots.

Habitat variable	Correlation coefficient
Small anthill density	-0.539
Tall vegetation	0.501
Bare ground	-0.472
Distance to forest	0.424
Nearest tree	0.374

(14% of 28 birds) were eaten by what we concluded to be an avian predator. During 2000, one female was eaten by an avian predator (3% of 31 birds). We found plucked feathers from these birds in grassland areas or among small, scattered conifer trees near forest edges. Attacks in these cases likely were made while the flickers were foraging, as avian predators probably would not enter nest cavities. In addition to the flickers eaten by avian predators, one male was found in 1999 cached in grass under a tree, and another male was cached in a mustelid den in 2000. This represents mortality rates of 18% in 1999 and 6% in 2000 for an approximate 27-day brood-rearing period.

DISCUSSION

Food abundance and food sources.—Within their home ranges, flickers were highly selective in their use of foraging sites (Fig. 1). DFA indicated a selective use of grassland areas with small anthills and greater percentages of bare ground (Table 2). The fact that anthill density was the best discriminating variable suggests that food abundance may be the most important variable determining foraging location. The small anthills upon which flickers foraged occurred only in areas with short vegetation and bare ground, so it is likely that these variables are related. We did not find small anthills under tall vegetation, although a few anthill mounds (5 cm diameter) that were built with small pieces of grass emerged on top of the litter, and disturbance to these

caused ants to swarm. Flickers foraged on these grass anthills occasionally.

Foraging flickers occasionally were flushed from the ground in an area lacking anthills, probe marks, or other soil disturbance but with ants that were walking along ant trails. We never observed flickers eating ants (mainly of the genus *Formica*) directly off large (usually 15–30 cm diameter) mounds, although they ate traveling *Formica*. Green Woodpeckers (*Picus viridis*) also have been observed feeding along ant trails during summer (Rolstad et al. 2000). *Formica obscuripes* (thatch ants) aggressively defended their nest mounds and swarmed objects placed near or on their nests, biting with their large mandibles and spraying formic acid (Hölldobler and Wilson 1990; CLE unpubl. data). This behavior may deter flickers from foraging on these mounds and explain why large anthills were not an important factor in foraging location. Ants such as *Lasius* spp. and *Tapinoma sessile* that occur in the smaller anthills and under rocks were less aggressive and ran around erratically when disturbed, probably making them more vulnerable to the foraging birds.

Even though cow dung was closer to foraging sites than random sites, it did not strongly predict the location of feeding sites (Table 1). Cow dung, which on our study site contained invertebrates such as *Lasius* and *Mirmica* ants (adults, larvae, pupae, eggs), as well as Coleoptera and unknown larvae, can be used by invertebrates for >30 days in temperate regions and can take as long as 340 days to fully degrade (Floate and Gill 1998, Moede et al. 1993). Although insects within cow dung seemed to be an important food source for flickers, especially on rainy and cold days when ants were not active on the ground surface, dung pieces were abundant and appeared uniformly distributed across the grassland with varying species and stages of invertebrate development.

Food availability and energetic costs of locating prey.—Flickers selectively used short grass and bare ground because ants probably were more accessible there. Since we found very few anthills in tall grass, the patches flickers selected for foraging had both a greater abundance and availability of prey. Rolstad et al. (2000) found three times greater overall biomass of ants in meadows and pastures than

in forests or clearcuts. Grazed areas tended to have greater invertebrate densities than ungrazed areas (Morris and Thompson 1998). Not only are insects more abundant and vulnerable on bare ground, but probing for subterranean larvae and pupae also would be easier in soil than in thick vegetation. In tall grass, both Northern Mockingbirds (*Mimus polyglottos*) and American Robins (*Turdus migratorius*) were forced to adopt alternative feeding styles such as using aerial perching or plucking small insects off grass strands, respectively, rather than gleaning larger insects from the soil surface (Roth 1979, Eiserer 1980). This reduced the feeding efficiency for both species. Mourning Doves (*Zenaida macroura*) avoided tall and dense vegetation and selectively foraged in areas with bare soil and short scattered vegetation when food was experimentally provided equally in both areas, probably because food was more difficult to detect in tall vegetation (Ostrand et al. 1996).

Tall or dense vegetation also may impede or alter movement of ground-foraging birds not equipped to move through it. American Crows (*Corvus brachyrhynchos*) avoided tall, dense vegetation because it probably was difficult to move through on foot (Sugden and Beyersbergen 1987, Sullivan and Dinsmore 1992). Movement of robins also was hindered by tall grass and changed their behavior from running or walking in short vegetation to hopping in tall vegetation (Eiserer 1980). Since flickers move along the ground by hopping and occasional running, taller vegetation may make locomotion more difficult and energetically costly.

Sex differences in foraging sites.—Woodpecker species that forage in trees, such as Downy (*Picoides pubescens*), Hairy (*P. villosus*), or White-backed (*Dendrocopus leucotos*) woodpeckers, often exhibit intrasexual differences in resource use, probably in order to avoid intraspecific competition (Jackson 1970, Gamboa and Brown 1976, Aulén and Lundberg 1991). In our study, the lack of differences between foraging sites of male and female flickers may be related to the similar size and morphology of the sexes (Wiebe 2000), their narrow diet range, and the homogenous structure within grassland foraging patches. It is more difficult for ground-foraging birds, which are restricted to foraging in

a horizontal plane, to partition the habitat or develop different foraging niches between sexes (Recher and Holmes 2000). Abundance of ants in patches on the ground also may be great enough that little intraspecific competition occurs and therefore different foraging strategies have not evolved. Male and female flickers foraged together without agonistic behavior and often near other insectivorous ground-foraging birds (Elchuk 2002).

Predation risk and distance to cover.—Avian predation may be an important factor in determining flicker foraging behavior, the location of feeding sites, and plumage color. The 12% mortality rate of flickers (mean for two seasons; $n = 7$ of 59 birds), is comparable to the 15% mortality rate found for Pileated Woodpeckers (*Dryocopus pileatus*) killed by Northern Goshawks (*Accipiter gentilis*) in Alberta during three breeding seasons ($n = 5$ of 33 birds; Bonar 2001). In addition to the Sharp-shinned and Cooper's hawks we observed, the Northern Harrier (*Circus cyaneus*) and Broad-winged Hawk (*Buteo platypterus*) also prey on flickers (Moore 1995). The ground-foraging Green Woodpecker in Italy is one of the main prey items of the Lanner Falcon (*Falco biarmicus*; Morimando and Pezzo 1997), whereas flickers make up 34% of the diet of Northern Goshawks in Wyoming (Squires 2000). Götmark and Unger (1994) suggested that the bright red, black, and white colors of many tree-foraging woodpeckers were aposomatic. However, ground-foraging woodpeckers such as the Northern Flicker and Green Woodpecker lack these conspicuous colors and are cryptic against the background where they forage (Short 1982). Ground-foraging birds also may be easier for predators to attack than tree-foraging species (Selås 1993).

Although different predators may have different attack strategies, foraging flickers chose sites closer to trees and forest edges (Tables 1 and 2) suggesting that these areas were safer. This conclusion is supported by observations in the field of flickers flying to nearby trees when flushed by observers or when an avian predator flew overhead. After scanning for a few minutes, they flew to the forest or dropped back to the ground to resume foraging. This use of protective vegetative cover also has been observed in other grassland

birds such as the Yellow-billed Magpie (*Pica nuttalli*), American Robin, Brewer's Blackbird (*Euphagus cyanocephalus*) and European Starling (*Sturnus vulgaris*) when a predator appears or upon hearing an alarm call (Verbeek 1964, 1972). Using areas with shorter vegetation also may enhance detection of predators and aid in early escape (Ostrand et al. 1996). Early detection may be important for flickers, which did not give alarm calls while foraging despite occurring in foraging flocks with conspecifics and other species.

In summary, we found that Northern Flickers were highly selective of ground cover characteristics within the grassland portion of their home ranges. Quantifying energy demands of adults and the rate of energy gain from foraging patches is needed to determine whether high quality foraging areas are limiting flicker reproduction and population densities. Our study suggests that, in addition to the management concern over retaining appropriate nest trees for woodpeckers on the landscape, attention should be given to characteristics of grassland at a microhabitat scale, and grazing practices that may alter it.

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